

# REPORT DOCUMENTATION PAGE

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13. ABSTRACT (Maximum 200 words)  IN ORDER TO EXPAND THE EARLIER STUDIES AND TO PROVIDE SUPPORT FOR FURTHER UV/OZONE FIELD STUDIES AT RMA, A BENCH-SCALE UV/OZONE SYSTEM HAS BEEN DESIGNED, PROCURED AND PLACED IN OPERATION. THE BENCH STUDIES WILL BE CONDUCTED AT WES ON VARIOUS SOURCE WATERS. THE MAJOR OBJECTIVES OF THE BENCH-SCALE STUDY ARE AS FOLLOWS: A.) TO ASSESS THE EFFECT OF ADDITIONAL OPERATIONAL PARAMETERS ON THE EFFICIENCY OF REMOVAL OF ORGANIC CONTAMINANTS FOR RMA GROUND WATER BY THE UV/OZONE SYSTEM; B.) TO PROVIDE DATA NEEDED IN THE DESIGN AND CONSTRUCTION OF A MODIFIED FIELD-SCALE UV/OZONE SYSTEM; C.) TO PROVIDE ADDITIONAL DATA FOR USE IN REFINING AND CALIBRATING A MATHEMATICAL MODEL OF THE UV/OZONE TREATMENT PROCESS; D.) TO ASSESS THE APPLICABILITY OF THE UV/OZONE PROCESS IN REMOVING CONTAMINANTS FROM ADDITIONAL SOURCE WATERS AT RMA.   DTIC QUALITY INSPECTED 3					
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TEST PLAN  
for  
LABORATORY BENCH-SCALE STUDY  
(Ultraviolet/Ozone Process)

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original

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## INTRODUCTION

1. Groundwater at Rocky Mountain Arsenal (RMA) has been found to contain traces of organic contaminants. Previous bench scale studies and a limited field-scale study conducted during FY 77 at RMA have proven the applicability of combined UV light and ozone oxidation in removing organic contaminants from the groundwater at RMA. The field study indicated that the treatment removal efficiency for organic contaminants is highly dependent on the operational parameters such as ozone mass flow, liquid flow, and UV light intensity. The field study was limited with respect to certain operational parameters that could not be easily controlled with the available UV/ozone reactor unit. These parameters include temperature, pH, pressure, and mixing.

2. In order to expand the earlier studies and to provide support for further UV/ozone field studies at RMA\*, a bench-scale UV/ozone system has been designed, procured, and placed in operation. The bench studies will be conducted at the Waterways Experiment Station (WES) on various source waters.

## OBJECTIVES

3. The main objectives of the bench scale study are as follows:

- a. To assess the effect of additional operational parameters on the efficiency of removal of organic contaminants from RMA groundwater by the UV/ozone system.
- b. To provide data needed in the design and construction of a modified field-scale UV/ozone system.

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← \*These field studies are discussed in a test plan titled "Test Plan for Field Scale System Study (Ultraviolet/Ozone Process)" dated January 1978.

- c. To provide additional data for use in refining and calibrating a mathematical model of the UV/ozone treatment process.
- d. To assess the applicability of the UV/ozone process in removing contaminants from additional source waters at RMA.

## METHODOLOGY

### Equipment

4. A two stage UV/ozone bench scale system was constructed for this study (Figure 1). Each reactor contains two UV lamps, an impeller, a gas introduction system, and a temperature control system. Each reactor vessel has a volume of 14 liters. Additional equipment such as flow meters, pressure gauges, thermometers, a UV intensity meter, and a ozone measuring system were obtained and provide for complete monitoring of all operational parameters. Ozone will be provided by a OREC ozone generator capable of using oxygen or air as a feed gas.

5. The bench-scale system can be operated in a batch or continuous mode. In the continuous mode, the system can operate with either concurrent or countercurrent flow. Each reactor has several ports which allow for the introduction of additives as in the case of pH control. These ports also provide an access for monitoring probes to the reaction chambers.

### Experimental

6. The UV/ozone bench study will begin with a series of break-in and calibration runs conducted on PW 3 source water from RMA. After an initial check of the system, testing will be conducted on water from PW 118 along with other source waters as directed by the OPM-CDIR. This

work will include a series of runs made with the reactors in a batch mode in order to obtain data on reactor kinetics. The rate of disappearance of organic contaminants will be related to UV light intensity and ozone mass flow along with additional parameters such as temperature and pH. Approximately 20 to 30 runs will be required in the batch mode after the initial calibration.

7. The next phase of the experiment will involve a series of continuous flow runs using information gathered in batch runs to determine operational parameter settings. A factorial type experiment will be conducted using a variety of parameter settings. This part of the experiment will be aimed at determining the optimum operational parameters associated with organic contaminant disappearance. Approximately 25 to 35 runs will be required during this phase of the study.

8. The final phase of the bench scale study will be concerned with providing support for the on-going field studies. The bench scale unit will be used to provide a quick means of determining the approximate operational parameter settings to be used.

#### Sampling and Analysis

9. The bench scale unit will be instrumented to facilitate continuous monitoring of operating parameters. Parameters to be monitored include:

- a. Ozone concentration in the feed gas.
- b. Oxygen concentration in the influent and effluent.
- c. pH of influent and effluent.
- d. Liquid and gas flow rates.

e. Temperature.

10. In order to establish a criteria for treatment, a representative constituent has to be identified on which to base treatment efficiencies. As in previous studies, DIMP (diisopropylmethylphosphonate) will be used as this representative substance. It is a stable compound, and it has been shown that efficient removal of this substance will normally insure removal of similar compounds. Other analyses will be conducted as follows:

a. Organic

- (1) DIMP
- (2) DCPD
- (3) Pesticides
- (4) Organosulfur compounds
- (5) Organophosphorus compounds
- (6) TOC (Total Organic Carbon)
- (7) COD (Chemical Oxygen Demand)

b. Metals

- (1) Iron
- (2) Lead
- (3) Mercury
- (4) Arsenic
- (5) Manganese
- (6) Sodium

c. Others

- (1) Total dissolved solids
- (2) Conductivity



- (3) Chloride
- (4) Fluoride
- (5) Bromide
- (6) Hardness
- (7) Alkalinity
- (8) Sulfate
- (9) Nitrite
- (10) Nitrate
- (11) Phosphate

The aforementioned analyses will be conducted throughout the study. Not all analyses will be conducted on every sample, but sufficient testing will be conducted to insure a thorough characterization of the different groundwater samples. Samples will be collected and analyzed according to Standard Methods. All of the analyses will be conducted at WES. RMA will provide quality control support for organic analyses on the order of three to four samples per week.

#### SCHEDULING

11. A time schedule for operation of the UV/ozone bench scale system during FY 78 is presented in Figure 2. Test plan development is scheduled for completion by January 1978. Procurement and installation of equipment is scheduled for completion by 6 January 1978. At that time, the bench-scale unit will be ready for operation. The rest of January will be used for equipment break-in and calibration. Batch studies will be conducted during February and March being followed by continuous studies in April and May. During the summer, the bench-scale unit will be used in support

of the field studies at RMA as needed. A summary report on work completed in FY 78 on the bench-scale study is due 1 October 1978.



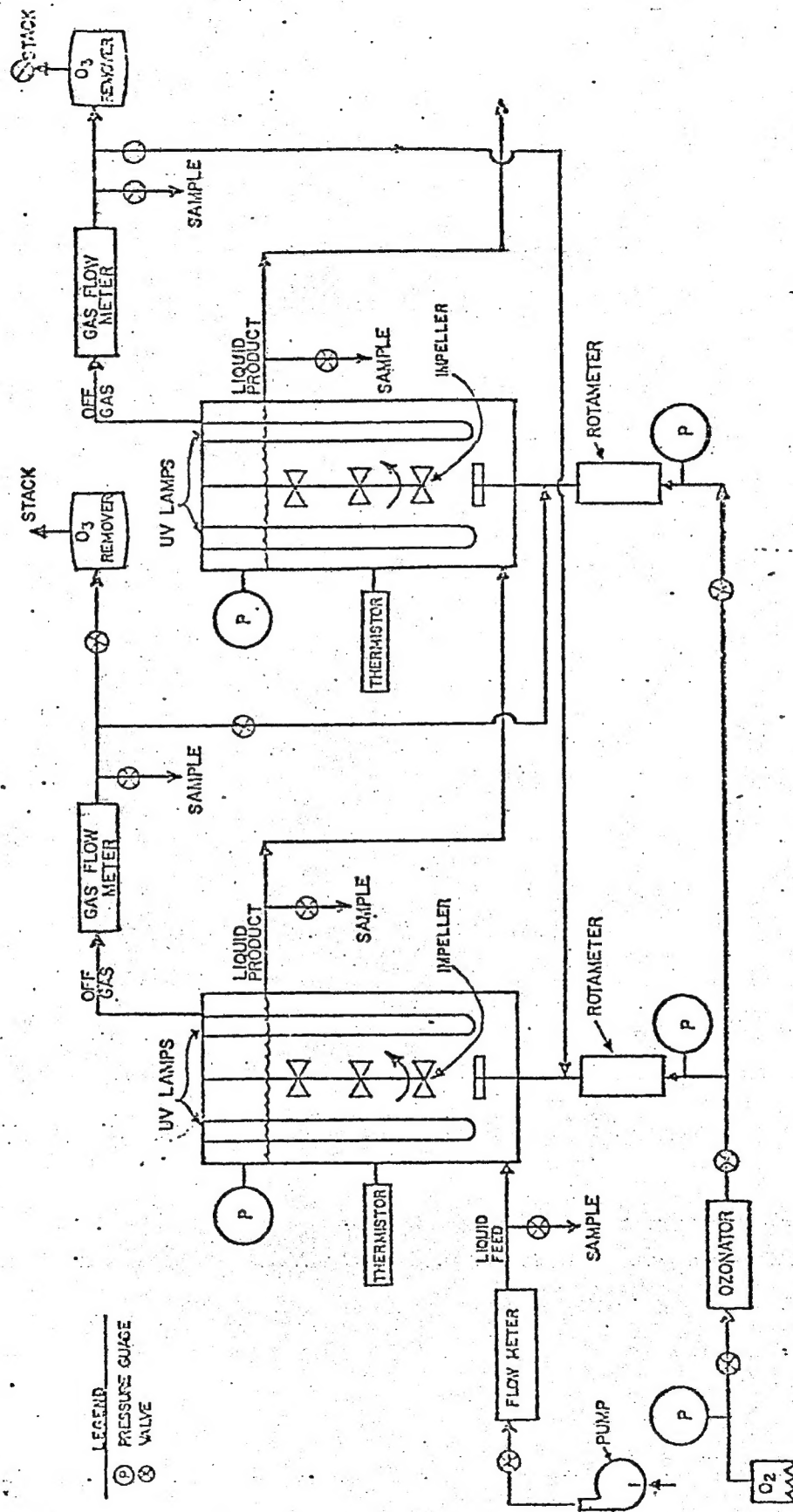


Figure 1. UV/Ozone Bench-Scale Unit

Figure 2.

UV/ozone Bench Unit Work Schedule

FY78

TASK	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept
A. Test Plan										
B. Setup of Equipment										
C. Break-in & Calibration										
D. Batch Studies										
E. Continuous Studies										
F. Support of Field Studies at RMA										
G. Prepare Summary Report of FY78 Work										